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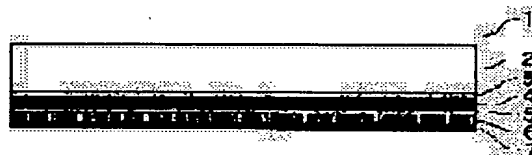
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## (54) FRONT LIGHT OF LIQUID CRYSTAL DISPLAY DEVICE

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a front light of a liquid crystal display device, by which the contrast of the liquid crystal display device can be heightened by forming a reflection preventing film on the lower surface of a light guide plate to prevent the generation of whitening, in the light guide plate wherein a hologram is formed on the lower surface thereof and the hologram is used as a reflection surface.

**SOLUTION:** The front light of the liquid crystal display device wherein the light guide plate consists of a light guide plate main body guiding and diffusing light from the end face opposed to a light source to the inner part and a film of a hologram polymer adhered to the lower surface of the light guide plate main body and which characteristically consists of a reflection surface downwardly reflecting light by the diffraction of light by the hologram, a protective film for protecting the film of the hologram polymer and the reflection preventing film disposed at the lower part of the protective film and preventing the reflection of light.



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CLAIMS

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## [Claim(s)]

[Claim 1] Light source. The light guide plate which introduces light into the interior, diffuses it from the end face which counters this light source, reflects light caused by the reflector, and illuminates a liquid crystal panel. The main part of a light guide plate with which it is the front light of the liquid crystal display equipped with the above, and the aforementioned light guide plate introduces light into the interior, and diffuses it from the end face which counters the aforementioned light source. The reflector which consists of a film of hologram polymer adhered to the inferior surface of tongue of this main part of a light guide plate, and reflects light caused by diffraction of the light by the hologram. It is arranged under the protection film which protects the film of the aforementioned hologram polymer, and this protection film, and is characterized by the bird clapper from the antireflection film which prevents reflection of light.

[Claim 2] The front light of the liquid crystal display according to claim 1 which the aforementioned protection film is a TAC film and is characterized by forming the antireflection film in the front face of this TAC film.

[Claim 3] The front light of the liquid crystal display according to claim 1 which the aforementioned protection film is a film of the high plastics for optics of transparency, and is characterized by forming the antireflection film in the front face of the film of this plastics for optics.

[Claim 4] The front light of the liquid crystal display according to claim 3 which the film of the aforementioned plastics for optics is PC film or a PMMA film, and is characterized by forming the antireflection film in the front face of this PC film or a PMMA film.

[Claim 5] The front light of the liquid crystal display according to claim 1 characterized by the acid-resisting film with which the aforementioned protection film is a TAC film, and the antireflection film was formed in the inferior surface of tongue of this TAC film having pasted up.

[Claim 6] The front light of the liquid crystal display according to claim 1 characterized by the acid-resisting film with which the aforementioned protection film is a film of the high plastics for optics of transparency, and the antireflection film was formed in the inferior surface of tongue of the film of this plastics for optics having pasted up.

[Claim 7] The front light of the liquid crystal display according to claim 6 characterized by the acid-resisting film with which the film of the aforementioned plastics for optics is PC film or a PMMA film, and the antireflection film was formed in the inferior surface of tongue of this PC film or a PMMA film having pasted up.

[Claim 8] The front light of the liquid crystal display according to claim 1 which the aforementioned protection film is an acid-resisting film with which the antireflection film was formed, and is characterized by carrying out to serve also as protection of hologram polymer and formation of an antireflection film by pasting up this acid-resisting film.

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## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] About the front light of a liquid crystal display which has the light guide plate which reflects light caudad by the reflector and illuminates a liquid crystal panel, especially, this invention forms a hologram in a light guide plate as a reflector, and relates to the front light of the liquid crystal display which reflects light caudad by this hologram while it introduces light into the interior and diffuses it from the end face which counters the light source and this light source.

[0002]

[Description of the Prior Art] The front light of a liquid crystal display is already well-known. The front light of this liquid crystal display has the light source and the light guide plate which counters this light source, and it is constituted so that light may be caudad reflected by the reflector and a liquid crystal panel may be illuminated while introducing light into the interior from the end face of a light guide plate and being spread inside. And in the usual front light, prism, such as V groove prism and stairway prism, is formed in the upper surface of a light guide plate, light is caudad reflected by making this prism into a reflector, and a liquid crystal panel is illuminated. One example of the V groove prism of a light guide plate is shown in drawing 6, and one example of stairway prism is shown in drawing 7. Here, the name of V groove prism or stairway prism is a name attached by whether the configuration of the prism formed in the upper surface of a light guide plate is in sight in the shape of a V groove, or it looks stair-like, and does not have an exceptional meaning for the performance as a reflector.

[0003] As shown in drawing 6 and drawing 7, as for the light guide plate 31, the stairway prism 33 (drawing 7) with which the V groove prism 32 (drawing 6) with which the V character-like slot was formed in the upper surface of a light guide plate 31 as a reflector, and the loose wavelike slot were formed is known. The light 34 and 35 on which these light guide plates 31 have the light source (not shown) in illustration left-hand side, and it was projected from this light source While being introduced into the interior of a light guide plate 31 from the left-hand side end faces 32a and 33a, repeating total reflection in respect of the upper and lower sides and being spread inside a light guide plate 31 The light which hit slant-face 32b on the left-hand side of [ illustration ] the slot used as the reflector in drawing 6 or slant-face 33b on the right-hand side of [ illustration ] the mountain used as the reflector in drawing 7 reflects caudad, and it is constituted so that liquid crystal panels 36 and 37 may be illuminated. Here, the liquid crystal panels 36 and 37 of illustration are reflected type color display liquid crystal panels, and the light which reflects caudad and illuminates liquid crystal panels 36 and 37 is drawn so that it may reflect on the front face of liquid crystal panels 36 and 37.

[0004] Drawing 8 is the notional cross section showing one example of a liquid crystal display. The liquid crystal display of this example is a liquid crystal display of color display, and the front light 44 which consists of a light guide plate 43 with which the light on which it was projected by the upper limit of a liquid crystal display 41 from the light source 42 and this light source 42 is introduced into the interior of the end-face 43a shell which counters the light source 42 is arranged. This light guide plate 43 reflects light caudad by reflectors (not shown), such as prism formed in the upper surface, and illuminates a liquid crystal panel 45 while it repeats reflection in respect of the upper and lower sides and diffuses the light A introduced into the interior of an end-face 43a shell inside a light guide plate 43.

[0005] Moreover, when surrounding environment is bright, outdoor daylight B carries out incidence to a light guide plate 43, and illuminates the downward liquid crystal panel 45. Therefore, in the liquid crystal display 41 of this example, it becomes it is possible to illuminate a liquid crystal panel 45 only with the light on which it is projected from environment, and possible to save power consumption, without using the light from the light source 42, when surrounding environment is bright enough.

[0006] Under the front light 44, the liquid crystal panel 45 with which the thing of various kinds of form is already well-known is arranged. The liquid crystal panel 45 of this example is a liquid crystal panel for the liquid crystal display of color display, the polarization and the compensating plate 46 with which the polarizing plate and the compensating plate were united in the method of the best are arranged, and the liquid crystal cell 47 is arranged at the lower part. A liquid crystal cell 47 is arranged as everyone knows in order of the upper glass substrate 48, a light filter 49, liquid crystal 50, a reflecting plate 51, and the lower glass substrate 52, and is united.

[0007] In this liquid crystal display 41, the light A on which it was projected from the light source 42 is introduced into the interior of a light guide plate 43 from end-face 43a of a light guide plate 43, is caudad projected on the light reflected by the reflector (not shown), and illuminates a liquid crystal panel 45 while being spread inside a light guide plate 43 by repeating reflection in respect of the upper and lower sides. After the lighting light of this liquid crystal panel 45 on which it reflected in and was projected caudad penetrates polarization and a compensating plate 46, and the upper glass substrate 48, penetrates only a color predetermined by the light filter 49 and penetrates only the portion as which a character or a configuration predetermined by liquid crystal 50 was displayed, it reflects the light which reached so far by the reflecting plate 51, and emits it to the upper surface shell exterior of a light guide plate 43 through the path of a basis. Thus, as for the liquid crystal display 41 of this example, a user can recognize now a character or a configuration predetermined [ aforementioned ]. Since a liquid crystal panel 45 is similarly illuminated when lighting light is outdoor daylight B, detailed explanation is omitted here.

[0008] At this time, it arises on the inferior surface of tongue of a light guide plate 43 that a part of light reflects up and it is emitted to the upper surface shell exterior of a light guide plate 43 as it is. If it mixes with the light to which this light penetrates a liquid crystal panel 45, and is emitted up, the contrast of a liquid crystal display 41 will fall and it will become the so-called white injury student \*\*\*\* cause. In order to prevent this white \*\*, arranging the antireflection film formed in the inferior surface

of tongue of a light guide plate 43 of vacuum deposition, the application of vacuum sputtering or a solution, etc., and maintaining the contrast of a liquid crystal display 41 highly is performed.

[0009] As an antireflection film arranged on the inferior surface of tongue of this light guide plate, forming an antireflection film in the inferior surface of tongue of a light guide plate conventionally was performed. Although sticking the acid-resisting film with which the antireflection film was formed on the inferior surface of tongue of a light guide plate was also considered, in the work which sticks an acid-resisting film, sticking an acid-resisting film on the inferior surface of tongue of a light guide plate, and arranging an antireflection film was not adopted as the formation method of an antireflection film from a reason that there are troubles, like a crack occurs or a foam remains between adhesion of dust, a light guide plate, and an acid-resisting film.

[0010] however, in the light guide plate which formed the hologram in the inferior surface of tongue of a light guide plate as a reflector which reflects the introduced light caudad Since the hologram is formed in the inferior surface of tongue of a light guide plate, an antireflection film can be formed in the inferior surface of tongue of a light guide plate neither by vacuum deposition nor vacuum sputtering. As a reflector, with the light guide plate which adopted the hologram as the inferior surface of tongue, white \*\* by the light reflected on the inferior surface of tongue of a light guide plate could not be prevented, but it was thought that it was difficult to make contrast of a liquid crystal display high by the antireflection film.

[0011]

[Problem(s) to be Solved by the Invention] this invention cancels the trouble of these conventional technology, forms a hologram in the inferior surface of tongue of a light guide plate, prevents generating which forms an antireflection film in the inferior surface of tongue of a light guide plate also in the light guide plate which makes this hologram a reflector, and is spoiled, and offers the front light of the liquid crystal display which can make contrast of a liquid crystal display high.

[0012]

[Means for Solving the Problem] this invention is what solves the trouble of such conventional technology. The light source, In the front light of a liquid crystal display which has the light guide plate which introduces light into the interior, diffuses it from the end face which counters this light source, reflects light caudad by the reflector, and illuminates a liquid crystal panel The main part of a light guide plate with which the aforementioned light guide plate introduces light into the interior, and diffuses it from the end face which counters the aforementioned light source, The reflector which consists of a film of hologram polymer adhered to the inferior surface of tongue of this main part of a light guide plate, and reflects light caudad by diffraction of the light by the hologram, It is arranged under the protection film which protects the film of the aforementioned hologram polymer, and this protection film, and is going to offer the front light of the liquid crystal display characterized by the bird clapper from the antireflection film which prevents reflection of light.

[0013] Here, the aforementioned protection film is a TAC film, the aforementioned protection film is a high film of the plastics for optics of transparency with desirable or forming the antireflection film in the front face of this TAC film, and it is desirable to form the antireflection film in the front face of the film of this plastics for optics. And the film of the aforementioned plastics for optics is PC film or a PMMA film, and it is desirable to form the antireflection film in the front face of this PC film or a PMMA film.

[0014] Or the aforementioned protection film is a TAC film and it is desirable for the acid-resisting film with which the aforementioned protection film is a film of the high plastics for optics of transparency, and the antireflection film was formed in the undersurface of the film of this plastics for optics to have pasted up desirably [ that the acid-resisting film with which the antireflection film was formed in the undersurface of this TAC film has pasted up ]. And the film of the aforementioned plastics for optics is PC film or a PMMA film, and it is desirable for the acid-resisting film with which the antireflection film was formed in the undersurface of this PC film or a PMMA film to have pasted up.

[0015] Furthermore, the aforementioned protection film is an acid-resisting film with which the antireflection film was formed, and it is desirable by pasting up this acid-resisting film to carry out to serve also as protection of hologram polymer and formation of an antireflection film.

[0016]

[Embodiments of the Invention] Hereafter, the detail of this invention is explained based on the drawing in which an example is shown. Drawing 1 or drawing 5 is the cross section showing typically the example of the light guide plate of the front light of the liquid crystal display of this invention. Here the composition of those other than the light guide plate of a front light, for example, the light source The white light or red according to white diode as an emitter like the conventional technology, what uses the white light which mixed the light from the light emitting diode of green and yellow — it is — the need — responding — a light pipe — using it — a line, since it can consider as the light source and has the same composition as the conventional technology Here, explanation is omitted about the composition of those other than the light guide plate of a front light.

[0017] Drawing 1 shows the 1st example of the light guide plate in the front light of the liquid crystal display of this invention, from the end face which counters the light source (not shown) and this light source, introduces light into the interior, diffuses it, and has the light guide plate 1 which reflects light below by the reflector and illuminates a liquid crystal panel (not shown). The light guide plate 1 of this example reflects light by the hologram, and serves as a reflector which reflects below the light which the film 4 of hologram polymer has pasted the undersurface of the main part 2 of a light guide plate which introduces light into the interior and diffuses it from the end face which counters the light source through adhesives 3, and the film 4 of this hologram polymer was introduced into the interior of the main part 2 of a light guide plate, and was diffused by diffraction of the light by the hologram. As a protection film which protects the film 4 of this hologram polymer, the TAC film (it is called a TAC film a triacetyl-cellulose film and the following) 6 currently generally used has pasted up through adhesives 5.

[0018] It is \*\* which repeats reflection of the introduced light, and is diffused and spread inside here as the main part 2 of a light guide plate was mentioned above. the film 4 of hologram polymer The hologram which will diffract this light that carried out incidence on the front face of the thin film adhered to the inferior surface of tongue of the main part 2 of a light guide plate, and will be caudad reflected in it if the light introduced into the interior of the main part 2 of a light guide plate carries out incidence to the field of this film is formed. As this hologram, a volume hologram is mentioned as what can be used suitably.

[0019] Moreover, the TAC film 6 is a film of a transparent cellulose, and in case the film 4 of hologram polymer is manufactured and kept, it is used for moisture proof of hologram polymer, and protection. In this example, an antireflection film 7 is used as a base material which coats the TAC film 6 currently used as this protection film by the application of vacuum deposition, vacuum sputtering, or a solution etc. as it is, and an antireflection film 7 is formed in the front face of the bottom.

[0020] as the matter which coats the front face of the base material of TAC film 6 grade with the shape of a thin film, and forms an antireflection film 7 by the application of vacuum deposition, vacuum sputtering, or a solution etc. as the antireflection film 7 was mentioned above — MgF<sub>2</sub>, aluminum 2O<sub>2</sub>, and ZrO<sub>2</sub> etc. — it is known An antireflection film 7 is independent, or uses these

matter combining several kinds, and is formed. When wavelength of light is set to  $\lambda$ , the thickness of an antireflection film 7 is  $\lambda/4$  or  $\lambda/2$ , according to the combination of the matter mentioned above, it chooses  $\lambda/4$  and  $\lambda/2$ , combines, and is formed.

[0021] Although cost can be reduced here since the TAC film 6 used for moisture proof of the film 4 of hologram polymer and protection can be used as it is when making the TAC film 6 into the base material of an antireflection film 7. The discharge gas produced on the TAC film 6 by vacuum deposition or vacuum sputtering, by the heat stress of the base material (TAC film 6) produced by expanding thermally in the case of vacuum deposition or vacuum sputtering, and cooling after that, and an antireflection film 7 etc. The adhesion intensity of the optical property of an antireflection film 7 or a film may become low, the reliability and the yield of a product are bad and a bird clapper may arise.

[0022] Drawing 2 tends to show the 2nd example of the light guide plate of the front light of the liquid crystal display of this invention, and tends to prevent the reliability of a product and the fall of the yield which are produced by discharge of the gas in the 1st example, or cooling after thermal expansion. The point which the film 4 of hologram polymer has pasted up the light guide plate 1 on the undersurface of the main part 2 of a light guide plate through adhesives 3 in the 2nd example, and the TAC film 6 has pasted up on the undersurface of the film 4 of hologram polymer as a protection film through adhesives 5 is the same as the 1st example.

[0023] In this example, the transparent acid-resisting film 9 with which the antireflection film was formed in the inferior surface of tongue of this TAC film 6 through adhesives 8 has pasted up. Thus, by constituting, the fall of the adhesion intensity of the optical property by the heat stress produced by generating of the discharge gas produced with the elevated temperature in the case of vacuum deposition or vacuum sputtering and subsequent cooling or a film can be prevented. Moreover, since marketing is also carried out, the acid-resisting film 9 can be received easily, and can choose and use the optimal thing from the acid-resisting film 9 of these marketing. There is a possibility that the yield may fall by generating of the defective by generating, dust, and the foam of the crack produced in case the acid-resisting film 9 is stuck on the other hand, while having the fault to which the thickness of the whole light guide plate 1 becomes thick being contained in a pasting side etc.

[0024] Drawing 3 and drawing 4 show the 3rd of the light guide plate of the front light of the liquid crystal display of this invention, and the 4th example, and in order that the reliability and the yield of a product by heat stress in the 1st example may prevent a bird clapper bad, they use the film of the high plastics for optics of the transparency it is well-known to form various kinds of antireflection films as a protection film. The example which used the PMMA film (it is called a PMMA film a polymethylmethacrylate film and the following) for drawing 3 for the example which used PC film (it is called PC film a polycarbonate film and the following) as a film of this plastics for optics as the 3rd example is shown in drawing 4 as the 4th example.

[0025] In these examples, the film 4 of hologram polymer has pasted up the light guide plate 1 on the undersurface of the main part 2 of a light guide plate through adhesives 3 like the 1st example. And it replaced with the TAC film 6 of the 1st example, the PC film 10 or the PMMA film 11 has pasted the undersurface of the film 4 of hologram polymer through adhesives 5, and the antireflection film 7 is formed in the undersurface of this PC film 10 or the PMMA film 11 of the application of vacuum deposition, vacuum sputtering, or a solution etc. like the 1st example.

[0026] In case an antireflection film 7 is formed in the PC film 10 or the PMMA film 11 by vacuum deposition or vacuum sputtering. Since processing conditions, such as temperature and a pressure, are clearer as compared with the TAC film 6. Since vacuum deposition or vacuum sputtering can be carried out more at low temperature while it is easily processible. The fall of the adhesion intensity of the optical property by the heat stress produced by generating of vacuum deposition or the discharge gas in the case of vacuum sputtering and subsequent cooling or a film can be prevented.

[0027] In addition, also in the 3rd and 4th examples, it can replace with the antireflection film 7 formed of vacuum deposition or vacuum sputtering like the 2nd example, the PC film 10 or the PMMA film 11 can be stuck as a protection film, and the transparent acid-resisting film 9 with which the antireflection film was formed in the undersurface through adhesives 8 can be pasted up. And as mentioned above, since marketing is also carried out, this acid-resisting film 9 can be received easily, and it can be used from the acid-resisting film 9 of these marketing, being able to choose the optimal thing. However, there is a possibility that the yield may fall by generating of the defective by generating, dust, and the air bubbles of the crack produced in case the acid-resisting film 9 is stuck, while having the fault to which the thickness of the whole light guide plate 1 becomes thick like the 2nd example in this case being contained in a pasting side etc.

[0028] Drawing 5 shows the 5th example of the light guide plate of the front light of the liquid crystal display of this invention, the film 4 of hologram polymer has pasted up the light guide plate 1 on the inferior surface of tongue of the main part 2 of a light guide plate through adhesives 3, and the transparent acid-resisting film 9 with which the antireflection film was directly formed in the inferior surface of tongue of the film 4 of this hologram polymer through adhesives 8 has pasted up. In this example, the adhesion intensity of generating of the discharge gas produced by the elevated temperature in the case of vacuum deposition or vacuum sputtering and subsequent cooling, the optical property by heat stress, or a film can prevent a fall by constituting in this way.

[0029] Moreover, since marketing is also carried out, the acid-resisting film 9 can be received easily, and can choose and use the optimal thing from the acid-resisting film 9 of these marketing. And in this example, since the acid-resisting film 9 is directly pasted up on the inferior surface of tongue of the film 4 of hologram polymer, thickness of the whole main part 1 of a light guide plate can be made thin. However, there is a possibility that the yield may fall by generating of the defective by generating, dust, and the foam of the crack produced in case the acid-resisting film 9 is stuck being contained in a pasting side etc.

[0030] As stated above, the front light of the liquid crystal display of this invention Hologram polymer 4 is pasted up on the inferior surface of tongue of the main part 2 of a light guide plate through adhesives 3. The antireflection film 7 formed in the inferior surface of tongue of this hologram polymer 4 at the TAC film 6, the PC film 9, or the PMMA film 10 is arranged. Or although the transparent film with which the TAC film 6 with which the antireflection film 7 was formed, the PC film 9, or the PMMA film 10 was stuck through the protection film, or the antireflection film was formed has pasted up this invention of the ability of various kinds of change and improvement to be performed in the range which is not limited to the method stated to the gestalt of the operation described above, and does not deviate from the summary of this invention is natural.

[0031]

[Effect of the Invention] As explained above, the front light of the liquid crystal display of this invention the inferior surface of tongue of the main part 2 of a light guide plate — adhesives 3 — minding — the film 4 of hologram polymer — pasting up — the inferior surface of tongue of the film 4 of this hologram polymer — direct — or An antireflection film 7 is formed through the protection film of the TAC film 6, the PC film 9, or the PMMA film 10. Or since the transparent film with which the antireflection

film was formed has pasted up A hologram can be formed in the inferior surface of tongue of a light guide plate, and the front light of the liquid crystal display which prevented generating which arranges an antireflection film on the inferior surface of tongue of a light guide plate, and is spoiled on it can be offered also in the light guide plate which makes this hologram a reflector.

[0032] Moreover, although there is a possibility that the yield may fall by generating of the defective by generating, dust, and the foam of the crack produced in case the TAC film 6 with which the antireflection film 7 was formed is stuck as a protection film being contained in a pasting side etc. Since it is necessary to stick a protection film on an inferior surface of tongue in order to protect the hologram of hologram polymer 4 Though the TAC film 6 with which the antireflection film was formed, the PC film 9, the PMMA film 10, or the acid-resisting film 9 is stuck Since generating of generating, dust, and the foam of a crack by sticking the protection film which protects a hologram being contained in a pasting side does not change exceptionally and does not produce an exceptional change in the incidence rate of a defective, trouble does not produce it practical.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is the cross section showing typically the 1st example of the light guide plate of the front light of the liquid crystal display of this invention.

[Drawing 2] It is the cross section showing typically the 2nd example of the light guide plate of the front light of the liquid crystal display of this invention.

[Drawing 3] It is the cross section showing typically the 3rd example of the light guide plate of the front light of the liquid crystal display of this invention.

[Drawing 4] It is the cross section showing typically the 4th example of the light guide plate of the front light of the liquid crystal display of this invention.

[Drawing 5] It is the cross section showing typically the 5th example of the light guide plate of the front light of the liquid crystal display of this invention.

[Drawing 6] It is the cross section showing one example of the V groove prism of a light guide plate.

[Drawing 7] It is the cross section showing one example of the stairway prism of a light guide plate.

[Drawing 8] It is the notional cross section showing one example of a liquid crystal display.

[Description of Notations]

- 1 Light Guide Plate
- 2 Main Part of Light Guide Plate
- 3 Adhesives
- 4 Film of Hologram Polymer
- 5 Adhesives
- 6 TAC Film
- 7 Antireflection Film
- 8 Adhesives
- 9 Antireflection Film Film
- 10 PC Film
- 11 PMMA Film

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